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Joint Trauma Analysis and Prevention of Injury in Combat (JTAPIC) Epidemiology and
Prevention of Injury in Combat (EPIC)

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14. ABSTRACT The new Epidemiology and Prevention of Injury in Combat (EPIC) program will conduct studies to identify ways to prevent warfighter injuries. For example, the initiative will investigate wounding events to determine the performance patterns of various types of equipment and vehicles. The program also is looking at safety and precautionary procedures associated with the equipment's use. Questions about whether proper procedures were followed and if not, why, could lead the investigators to discover patterns in warfighters' behavior that contribute to injury. The studies will examine equipment such as helmets, hearing protection, head-mounted devices, vehicle armor, restraints and seating systems.				
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Introduction

Iraqi insurgents launched four times as many attacks using improvised explosive devices (IEDs) in 2007 as in 2003, according to the *Army Times*. With the rise in IED use, the military is reevaluating protective devices to determine whether modifications in the current equipment could improve service members' safety.

The new Epidemiology and Prevention of Injury in Combat (EPIC) program will conduct studies to identify ways to prevent warfighter injuries. For example, the initiative will investigate wounding events to determine the performance patterns of various types of equipment and vehicles. The program also is looking at safety and precautionary procedures associated with the equipment's use. Questions about whether proper procedures were followed and if not, why, could lead the investigators to discover patterns in warfighters' behavior that contribute to injury. The studies will examine equipment such as helmets, hearing protection, head-mounted devices, vehicle armor, restraints and seating systems.

EPIC, which is headquartered at the U.S. Army Aeromedical Research Laboratory, functions under the Joint Trauma Analysis and Prevention of Injury in Combat program.

There were three (3) technical objectives documented for this program:

- Establish a scientific discipline, process and policy to systematically investigate combat related trauma events to discover positive and negative attributes of equipment and vehicles in Soldier survivability.
- Analyze combat equipment, and correlate to trauma, injury patterns and survivability.
- Provide actionable information to Combatant Commanders, combat and materiel developers and other stakeholders.

To accomplish this program's established technical objectives, the following five (5) tasks were proposed. Tasks 1-4 were designed to be accomplished during Phase I of the program with continuing effort being accomplished with Task 5 during Phase II of the program.

Task 1: Site organization, preparation and training. Months 1-4.

- a. Hire Project Manager and core team.
- b. Review Epidemiology and Prevention of Injury in Combat (EPIC) plan and gap analysis for equipment and training needs.
- c. Project Manager will work with USAARL's Program Manager to prepare for full implementation of the EPIC capability.
- d. Establish laboratory infrastructure to support initial capability for forensic analysis to include renovation, security upgrades, and equipment storage.

Task 2: Establish EPIC operational capability. Months 2-6.

- a. Hire initial combat equipment analysis personnel.
- b. Coordinate with selected Combatant Command to demonstrate collection of injury circumstances data and assess the embedding process and capabilities.
- c. Execute forensic analysis pilot project to analyze equipment performance correlated with injury patterns.

Task 3: Study Warfighter injury surveillance and blast surveillance. Months 4-12.

- a. Conduct denominator-based analyses of PPE among Soldiers with improvised explosive devices (IED) injuries.
- b. Review morbidity and mortality related to various types of personal and vehicle mounted life-support/protective equipment.
- c. Continue correlation analysis of equipment and injury severity to add capabilities to support the Joint Trauma Analysis and Prevention of Injury in Combat (JTAPIC) Program's medical research as a method of continuous improvement to Warfighter survivability.

Task 4: Conduct analysis capability. Months 4-12.

- a. Testing of destructive and non-destructive testing of PPE to determine material characteristics and correlate with collected field data.
- b. Conduct analysis of equipment as the JTAPIC provides guidance to the EPIC Program
- c. Provide recommendations for PPE and vehicle mounted occupant equipment improvements.

Task 5: Continue spiral development of capabilities to support EPIC functions. Months 12-24.

- a. Continue to identify preventable mechanisms of Warfighter injury by analysis of protective equipment and patterns of combat injury.
- b. Continue to communicate patterns of injury and countermeasure strategies to equipment developers, program managers, military customers and leadership.

BODY OF ANNUAL REPORT

The US Army Medical Research and Materiel Command (USAMRMC) desires the rapid integration of the Epidemiology & Prevention of Injury in Combat (EPIC) program which is located at the U.S. Army Aeromedical Research Laboratory (USAARL). The EPIC program supports USAMRMC Joint Trauma Analysis and Prevention of Injury in Combat (JTAPIC) initiative.

The Department of Defense (DoD) lacks the systematic methodology, infrastructure, and information to conduct well-informed, data-driven combat injury risk assessments, make informed decisions, and provide Commanders with actionable information influencing Tactics, Techniques, and Procedures (TTPs) and Doctrine, Organization, Training, Leadership and Education, Materiel, Personnel, and Facilities (DOTLM-PF) designed to mitigate combat related injuries specifically due to improvised explosive devices (IED).

The EPIC team addresses basic questions regarding mechanisms of injury, the performance of Personal Protective Equipment (PPE), vehicle-mounted occupant protection systems and other equipment in combat operations, and other questions regarding combat wounding circumstances and provide data for future DOTLM-PF recommendations. EPIC's research efforts supports JTAPIC's efforts to provide an analytical capability to assess Service casualty data to facilitate and focus research, address injury patterns correlated with PPE and other equipment in combat operations, and influence materiel development for implementation across DoD to enhance survivability.

In order to reduce or eliminate wounds resulting from Improvised Explosive Devices (IEDs), and other combat operations, it is essential that DoD collects and carefully analyzes the circumstances of each injury event. As of March 6, 2006, the Joint Theater Trauma Registry (JTTR) contains extensive electronic medical information on 7,108 seriously injured casualties. However, injury event data correlated to operational scenarios (e.g. mission, time of day, personnel location, threat, personnel protective equipment (PPE), vehicle-mounted occupant protection systems, angle of attack, environmental factors, etc.) are not available in sufficient fidelity and quantity to allow meaningful analysis of injury treatment, protection and preventive measures. A comprehensive analysis of operational events linked to use of protective combat equipment and correlated to injury patterns is a critical capability gap. The lack of complete information hampers the ability to fully understand the nature of the injuries and contributing factors and to quickly design, evaluate, and field the appropriate solutions reducing Service Member risk while minimizing the number of casualties or extent of injury. This knowledge is critical for Combatant Commanders and other DoD Components, especially for combat and materiel developers, operational planners and medical personnel.

USAARL is the U.S. Army's leading laboratory for conducting medical research in combat injury prevention, head injury prevention, visual performance and protection, acoustic performance and protection, and operator performance under stress. The mission of USAARL is to preserve and enhance the health, safety, combat effectiveness, and survivability of the U.S. Army aviator and Soldier. Research of protective equipment of the Soldier continues to be of utmost importance. This research program will look at the basic traumatic injury and mortality patterns tied to events, then link equipment damage patterns directly to the injury patterns to determine what protection gaps exist. From there, a recommendation can be made as to the direction of protection systems development which might serve to counter those vulnerabilities. USAARL is part of a consortium of military entities who share information to prevent injuries in combat.

Joint Trauma Analysis and Prevention of Injury in Combat: JTAPIC Partners

- Medical Research and Material Command (JTAPIC PMO)
- United States Army Aeromedical Research Laboratory (MRMC-USAARL)
- Naval Health Research Center (NHRC)
- National Ground Intelligence Center (NGIC)
- Army Research Lab (ARL)
 - Survivability/Lethality Analysis Directorate (SLAD)
- United States Army Infantry Center (USAIC)
 - Directorate of Combat Development (DCD)
- Program Executive Officer Soldier (PEO-Soldier)
- Institute of Surgical Research (MRMC-ISR)
 - Joint Theater Trauma Registry (JTTR)
- Office of Armed Forces Medical Examiner (OAFME)
 - American Registry of Pathology
- Marine Corps Systems Command (MCSC)



Task 1: Site organization, preparation and training. Months 1-4.

- a. Hire Project Manager and core team.
- b. Review Epidemiology and Prevention of Injury in Combat (EPIC) plan and gap analysis for equipment and training needs.
- c. Project Manager will work with USAARL's Program Manager to prepare for full implementation of the EPIC capability.
- d. Establish laboratory infrastructure to support initial capability for forensic analysis to include renovation, security upgrades, and equipment storage.

Discussion.

With the hiring of the initial core members of the EPIC team in November, 2007; those positions being the Project Manager, Safety Officer / Analyst, and Data Analyst, the initial efforts were to facilitate infrastructure updates to include painting, electrical outlet modifications, carpeting, procurement and assembly of office furniture, computers, printers and telephones.

Addition to the core team occurred later during the first period of the program which included an Injury Epidemiologist in August 2008. The rationale for delaying adding this expertise to the team was event driven rather than time driven. Having more readily available access to injury data bases was not in place early on during the program.

Also critical to the continuing success of the program was installation of requisite Secret Internet Protocol Network (SIPRNet) to allow for expanded use of classified systems within USAARL and with other JTAPIC Partners. This included SIPRNet hardware being installed in ten (10) additional office locations to include the USAARL Command Group area, SIPRNet Room Physical Security enhancements to preclude unauthorized access from the true floor to ceiling for this Restricted Area, adding a digital electronic lock (same as those found on GSA approved security containers) and an Integrated Commercial Intrusion Detection System (ICIDS).

Also required for implementation of the SIPRNet system was significant updating of the USAARL SIPRNet Standard Operating Procedures (SOP) and SIPRNet Accreditation Packet. These efforts resulted in facilitating establishment of the capability for preparation of data sharing and storage may include establishing SIPRNET capability, to include secure VTC capabilities and negotiating military data access protocols. Because of the sensitive nature of the analysis, physical security had to be established as well as measures to ensure data integrity to produce a scientifically valid research process.

Assessment given program development to date is that subtask b should be moved to Task 5 to be accomplished during Phase II of the program.

Subtask c has been accomplished to the satisfaction of the Project Manager in coordination with the USAARL Program Manager.

Subtask d has been accomplished but may require further resourcing dependent on what additional equipment / facility upgrades / procurements develop over time with the program.

Task 2: Establish EPIC operational capability. Months 2-6.

- a. Hire initial combat equipment analysis personnel.**
- b. Coordinate with selected Combatant Command to demonstrate collection of injury circumstances data and assess the embedding process and capabilities.**
- c. Execute forensic analysis pilot project to analyze equipment performance correlated with injury patterns.**

Discussion.

Subtask a, also addressed above has been accomplished with the core team established and in place (Safety Officer, Injury Epidemiologist and Data Analyst). This team has demonstrated its proficiency by virtue of being recognized formally by the Commanding General, US Army Center for Health Promotion and Preventive Medicine (USACHPPM). USAARL entered a poster for the 11th Annual Force Health Protection Conference in Albuquerque, New Mexico in August, 2008. The poster was titled "Prevention of Injury in Tactical Vehicle Roll-over Accidents – HMMWV" (attached).

Subtask b will not be accomplished by USAARL directly but is being addressed by the JTAPIC Program Office at Fort Detrick, Maryland on behalf of the JTAPIC Partnership. Given this development over this period, this subtask will no longer be resourced by USAARL within the JTAPIC / EPIC program. USAARL does, however, participate on bi-weekly secure video teleconferences (SVTC) hosted by the JTAPIC Program Office and attended by all JTAPIC Partners. These SVTCs include ongoing coordination efforts facilitated by JTAPIC with organizations, both domestically (Tank Automotive Research / Development and Engineering Center (TARDEC) and overseas with units / organizations in Iraq and Afghanistan. Similarly, USAARL has established a working relationship with the Aviation Shoot Down Assessment Team (ASDAT), co-located on Fort Rucker, Alabama.

Regarding subtask c, this has been accomplished by virtue of the Mine Resistant and Ambush Protected (MRAP) Accident Report completed and provided to the US Army Combat Readiness / Safety Center (USACR/SC) as a pilot project with intent being to continue this methodology / success and will warrant continued budget resourcing consideration for the JTAPIC / EPIC program. This report is not attached to this annual report due to its sensitive nature. Also developed during this award period was the Operational Survival Analysis Tool (OSAT) by Mr. Kraig Pakulski, Data Analyst for the program. An information paper (attached) was also developed by Mr. Pakulski and was distributed to all JTAPIC Partners for their use. In general, OSAT affords the team to accept and process available data via the following tool categories:

- Submittal and Selection
- Extraction / Transformation / Load
- Analysis
- Reporting Systems
- Presentation

Task 3: Study Warfighter injury surveillance and blast surveillance. Months 4-12.

- a. Conduct denominator-based analyses of PPE among Soldiers with improvised explosive devices (IED) injuries.**
- b. Review morbidity and mortality related to various types of personal and vehicle mounted life-support/protective equipment.**
- c. Continue correlation analysis of equipment and injury severity to add capabilities to support the Joint Trauma Analysis and Prevention of Injury in Combat (JTAPIC) Program's medical research as a method of continuous improvement to Warfighter survivability.**

Discussion:

Subtask a is not being accomplished by USAARL directly but indirectly and in coordination with the JTAPIC Program Office and specifically by the Program Manager – Soldier Equipment (PM-SEQ) organization, another JTAPIC Partner.

Subtasks b and c continue to be developed but are not yet realized and will continue to be resourced for the JTAPIC / EPIC program, dependent on continued development of working relationships with the Office of the Armed Forces Medical Examiners (OAFME), Institute for Surgical Research (ISR) (both JTAPIC Partners) and the USARCR/SC.

Task 4: Conduct analysis capability. Months 4-12.

- a. Testing of destructive and non-destructive testing of PPE to determine material characteristics and correlate with collected field data.**
- b. Conduct analysis of equipment as the JTAPIC provides guidance to the EPIC Program**
- c. Provide recommendations for PPE and vehicle mounted occupant equipment improvements.**

Discussion:

Similar to above tasks / subtasks, subtasks a and c have not yet been accomplished and will continue to be developed by USAARL; subtask b is not being accomplished by USAARL (with regard to PPE) directly but indirectly and in coordination with the JTAPIC Program Office and specifically by the PM-SEQ. Having said that, two High Mobility Multiple Wheeled Vehicle (HMMWV) Turret Gunner Restraints have been received by USAARL, tested / analysed, and draft Technical Memorandums are pending review / approval by USAARL leadership.

Task 5: Continue spiral development of capabilities to support EPIC functions. Months 12-24.

- a. Continue to identify preventable mechanisms of Warfighter injury by analysis of protective equipment and patterns of combat injury.**
- b. Continue to communicate patterns of injury and countermeasure strategies to equipment developers, program managers, military customers and leadership.**

Discussion:

As addressed above within Task 1 discussion, movement of subtask b will be addressed as part of Task 5 and accomplished during the second period of the JTAPIC / EPIC program.

In order to augment the USAARL capabilities to accomplish Task 5, resourcing efforts will include concept to add another Combat Equipment Analyst (Safety Officer) and Research Engineer to the team.

Key Research Accomplishments

1. A poster titled “Prevention of Injury In Tactical Rollover Vehicle Accidents – HMMWV” won “best research presentation” out of 68 “research” entries. The award was followed by a “star note” from CG CHPPM. Note follows:

Dear [Team Member] Members are: Robert Giffin, MSOH, author, Kraig Pakulski, MS, Paul St Onge, PhD, Parrish Balcena, MD, MPH, Joseph McEntire, MS, LTC Shean Phelps, MD. MPH

“Congratulations! Your poster was judged by your peers to be the best in the research category at the 11th Annual Force Health Protection Conference in Albuquerque, New Mexico. Thank you for your hard work, dedication and contributions to this year’s conference.”

Brigadier General Michael B. Cates.

U.S. Army Commanding

2. The JTAPIC partnership was recognized with the JTAPIC collaboration award by the Assistant Secretary of the Army Logistics, Acquisition Logistics and Technology (ASA(ALT)).

This note from the JTAPIC PMO COL Halverson followed:

“I personally wanted to send a message to let you all know that it was just announced that the JTAPIC partnership will be awarded the ASA(ALT) collaboration of the year award. Congratulations and thanks to all of you for all the hard work that you do to protect the war-fighter. Your hard work and dedication are why this partnership is quickly becoming the example of collaboration and cooperation across the DOD. The award will be presented at the upcoming acquisition banquet on the 5th of October. Thank you all!”

Kelly M. Halverson, PhD LTC, MSC, PM, JTAPIC and Army Program Coordinator DoD Blast Injury Research Program

3. USAARL personnel, CW5 Tom Morgan, Chief ALSERP, accompanied a USACR/SC accident investigation team to OEF to investigate an MRAP rollover and subsequent drowning of three Soldiers. CW5 Morgan using the ALSERP model sent vehicle seats, restraints, inertia reel and cargo strap back to USAARL for analysis. A USAARL Technical Report was written by Operational Survival Analysis Branch (OSAB), Bob Giffin, author, approved by the command and sent to USACR/SC for inclusion in their final report.

Reportable Outcomes

1. Secret Internet Protocol Network (SIPRNet) installation completed, awaiting accreditation and implementation by USAARL staff and Fort Rucker installation.
2. A new rapport has been established with the Tank Automotive Research, Development, and Engineering Center (TARDEC) and Tank and Automotive Command (TACOM).
3. Reports on HMMWV Turret Gunner's restraints, Army aircraft shoot down analysis and MRAP accident developed.

Conclusions

1. USAARL and the JTAPIC / EPIC team have gained credibility within the JTAPIC Partnership and is beginning to establish itself as a resource for injury and equipment analysis “in-theater.”
2. The OSAT is a tool that is being exploited and used extensively by the USAARL team and has been shared with the JTAPIC Program Office and Partners to them in enhancing their abilities to analyze data.

Operational Survival Analysis Branch (OSAB)
United States Army Aeromedical Research Laboratory (USAARL)
Fort Rucker, Alabama

Operational Survival Analysis Tools **(OSAT)**

Developed by:
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Introduction: OSAT has been utilized since the inception of the Operational Survival Analysis Branch in November 2007. At that time, OSAB was tasked with the analysis of an Excel spreadsheet that was full of redundancies and initially dismissed as too cumbersome to be useful. After importing it into MS Access and using specialized querying techniques, we then successfully answered a number of questions. This initial task proved the value of US Army Combat Readiness / Safety Center (USACR/SC) data and provided the impetus behind the development of a Memorandum of Agreement between USAARL and USACR/SC which will allow direct access to their “aviation” and “ground” accident databases.

This initial task was accomplished from a single discipline (accidents) and we knew we would be required to interact with subject matter experts (SME) specializing in other disciplines. To prepare for this complexity, it was imperative that a tool be developed to manage the interaction of multiple SMEs and data architects. This tool would also need to minimize redundancy by allowing efficient sharing of data sources, queries and findings.

To expedite data processing, OSAT recognizes five phases of “data analysis” needed to validate findings needed for technical report. OSAT corresponds to these phases and they are as follows:

1. Submittal and Selection: This form was developed to guide the process of receiving, identifying and logging changes to source data before importing it into a database management system. A data “submittal” could be comprised of text files, spreadsheets, image files, and video files etc. The form accepts “links” to existing files, is designed for an administrative assistant to manage the reception of a large submittal that could come from multiple sources and inspire multiple hypotheses.

2. ETL: Extraction, Transformation and Loading: This phase is represented by compendium of queries, forms and VBA code that extract data from multiple text or spreadsheet files and transforms it into a format that can be used to qualify, quantify, integrate and recommend data for analysis. This step is the primary responsibility of the data analyst, saving an SME an enormous amount of time by pre-processing it.

3. Analysis: The analysis of data is a cooperative effort between the SME and data architect. For example, OSAT includes a set of interactive forms that allow the SME to create a list of key words that search a given dataset, mark records based on the presence of pre-determined keywords, and quantify the presence of that search item (i.e. water, dust or sand as related to “HMMWV rollovers”). This tool is especially useful in filtering the “free text” found in an accident investigation. The data architect assists the SME by programming the search form to produce the most useful results. Some analyses have been standardized (i.e. bar graphs of the populations rank or age).

4. Reporting: This is the most useful component of OSAT and designed primarily for the SME. The word “report” refers to anything an SME may want to print but “data summary” is perhaps a more accurate description of our system’s output. Our “Question-Answer Report” is an interactive form allowing an SME and a data analyst to work together on data summaries.

There are four steps most commonly found in the development of a data summary:

- 1) SME enters questions based on a hypothesis.
- 2) Data analyst writes queries to substantiate a statistical argument, categorizes said queries as qualified, quantified or integrated and assigns them to the appropriate question(s).
- 3) SME runs these queries, considers the data analyst’s findings, and either recommends changes or writes an appropriate response.
- 4) When necessary, all information can be conveniently printed in a standardized data summary format for further study or presentation.

Note: We currently use this interactive form to present data on current projects which allows to us to present “live data” that would otherwise require the creation of a Powerpoint presentation with MS Sharepoint Services (to insert this live data).

5. Presentation: After a data point in a data summary is complete it may be necessary to identify its intended audience. Once identified, as “confidential” or “public” for example, an SME can select those data points he wants to use in a future briefing and print them as needed.

Following is a hierarchal chart of the OSAT menu system. The system is modified “as needed” and, as such, many elements of the system may be developed per user input.

OSAT Menu System

1-0-0: Submittal and Selection

- 1-0-0: Submittal and Selection
 - Submittal and Selection Form

2-0-0: Extraction/Transformation/Load

- 2-1-0: Extractions
- 2-2-0: Transformations
 - Transformation Tool
- 2-3-0: Loading

3-0-0: Analysis

- 3-1-0: Qualitative Analysis
 - 3-1-1: Environmental Analysis
 - 3-1-2: Equipment Analysis
 - 3-1-3: Injury Analysis
 - Injury/Event Key Word Search
 - Injury Identification
- 3-2-0: Quantitative Analysis
 - 3-2-1: Environmental Analysis
 - 3-2-2: Equipment Analysis
 - 3-2-3: Injury Analysis
 - Injury Statistics
 - Individuals' Age
 - Individuals' Rank
- 3-3-0: Comparative Analysis
 - 3-3-1: Injuries and Equipment
 - Qualitative Integration
 - Quantitative Integration
 - 3-3-2: Injuries and Environment
 - Qualitative Integration
 - Quantitative Integration

4-0-0: Reporting Systems

- 4-1-0: Question Answer Report
 - Subject Matter Expert: Safety
- 4-2-0: Statistical Reports
 - Injury Statistics
 - Seatbelt Injury Statistics
- 4-3-0: Interdisciplinary Reports

5-0-0: Presentation Systems

- 5-1-0: In House Presentations
 - Assign Audience(s) to Presentation Material
- 5-2-0: USAARL Presentations
- 5-3-0: Partner Presentation
- 5-4-0: Customer Presentations

6-0-0: Administrative Tools

- 6-0-0: Fill Dates Form
- 6-1-0: Keywords
- 6-2-0: References
- 6-3-0: Glossaries
- 6-4-0: Personnel



Prevention of Injury in Tactical Vehicle Rollover Accidents – HMMWV

Robert Giffin, MSOH; Kraig Pakulski, MS; Paul St Onge, PhD; Parrish Balcena, MD MPH; B. Joseph McEntire, MS; LTC Shean E. Phelps, MD MPH
United States Army Aeromedical Research Laboratory, Fort Rucker, AL



Introduction

High Mobility Multipurpose Wheeled Vehicle (HMMWV) is a mainstay of the U.S. Army vehicle fleet, designed to transport personnel and light cargo. Recently, tactical considerations in combat have prompted the addition of reinforced armor plating systems onto the HMMWV, not originally designed to accept such improvements. "Up-Armor" kits, while reducing probability of platform penetration and increasing occupant survival, alter center of gravity and increase risk of "roll over" type mishaps.

The Operational Survivability Analysis Branch, USAARL, Fort Rucker, Alabama, conducted a comprehensive review of ground vehicle accident data, focusing on the incidence of morbidity and mortality associated with rollover mishaps. This poster provides an epidemiological overview of this injury data and provides a starting point for discussion of preventive and occupational modalities to examine and reduce these injuries.

In unpublished research conducted by McEntire, et al, there is a perception among Soldiers that restraint use in the HMMWV negatively impacts their ability to immediately respond during combat situations and/or emergency egress. Additionally, restraints are reported to hinder performance of mission duties, be incompatible with gear, and difficult to don and doff. These attitudes spill over into non-combat/non-emergency situations, resulting in overall reduced restraint use.

Methods

Table 1. Inclusion criteria.

Study design:	Retrospective case-control study
Population:	Soldiers & civilians involved in HMMWV rollovers
Dates:	Jul 1989 to Oct 2007
Data Source:	U.S. Army Combat Readiness / Safety Center (USACRC)
Vehicle platform:	HMMWV
Incident type:	Accidents only
Accident type:	Over-turned / Rollover
Distribution:	Worldwide
Inclusion criteria:	HMMWV rollover
	Restraints reported as present in vehicle
	Restraint use reported as Yes or No

Table 2. Army accident classification.

Army Accident Classification		
Accident Class	Property Damage	Injury Outcome
A	An Army accident in which the resulting total cost of property damage is \$1,000,000 or more.	Injury and/or occupational fitness results in a fatality or permanent total disability.
B	An Army accident in which the resulting total cost of property damage is \$200,000 or more, but less than \$1,000,000.	An injury and/or occupational fitness results in permanent partial disability, or when three or more personnel are hospitalized as inpatients as the result of a single occurrence.
C	An Army accident in which the resulting total cost of property damage is \$20,000 or more, but less than \$200,000.	A nonfatal injury that causes any loss of time from work beyond the day or shift on which it occurred, or a nonfatal occupational fitness that causes loss of time from work (for example, 1 work day) or disability at any time (lost time case).
D	An Army accident in which the resulting total cost of property damage is \$2,000 or more but less than \$20,000.	Nonfatal injuries/illnesses (restricted work activity, light duty, or profile) will only be recorded in ASIMS in conjunction with recordable property damage accidents.

The property value of a HMMWV is <\$10K; Class A & B accidents are classified on the basis of fatality or injury

- Two data fields were used to determine restraint usage (inclusion criteria):
1. "PPE Description" listed all of the Personal Protective Equipment (PPE) identified and cataloged in the HMMWV investigation
 - Descriptions included restraint system, seatbelts, and turret gunner strap
 2. "PPE Use Description" described the PPE usage / presence at the time of investigation
 - Values were Yes, No, or Unclear



Summary Statistics

- 454 HMMWV rollover accidents
- 789 individuals injured
- 56 (7.1%) of individuals were excluded because restraints were not noted to be present in the vehicle (data entry error)
- 56 (7.6%) of individuals were excluded due to unclear restraint use
- 1167 injuries sustained

Table 3. Subject demographics.

Age	Mean: 25.2 yr	Range: 14 - 61 yrs	
Sex	Male: 661 (83.8%)	Female: 64 (8.1%)	Unreported: 64 (8.1%)
Rank	Officers: 30 (3.8%)	Enlisted: 693 (87.8%)	Unreported: 66 (8.4%)
Vehicle Occupants	Drivers: 332 (42.1%)	Passengers: 402 (51.0%)	Unreported: 55 (7.0%)

Table 4. Soldier injuries and percent restraint use for each accident classification.

Soldier injuries and restraint use								
Accident Class / Injury Outcome	Class A		Class B		Class C		Class D	
	# indiv	SB = Y / N / NR	# indiv	SB = Y / N / NR	# indiv	SB = Y / N / NR	# indiv	SB = Y / N / NR
Fatal	100	36% 50%	15	28% 15%	28	73% 21%	5	90% 5%
Disability	7	57% 29%	18	68% 33%	26	73% 21%	5	90% 5%
Lost Workday	65	37% 62%	62	68% 80%	24	73% 21%	5	90% 5%
Restricted Work	9	67% 4%	4	50% 25%	25	68% 80%	21	58% 10%
1st Aid	35	37% 13%	13	38% 80%	80	10% 58%	58	10% 58%
Total	216	21%	37	34%	341	79%	79	32%

Note: SB = Restraint

Results

Figure 1. Percent restraint use by Accident Class

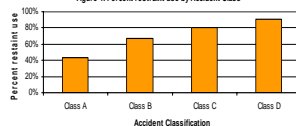


Figure 1 demonstrates that 44% of Soldiers involved in Class A accidents were wearing restraints. This indicates that the group involved in the "catastrophic" accidents has the lowest restraint use; inversely, the group involved in the "minor" accidents (Class D) had the best rate of restraint usage (91%). This strongly suggests that restraint use is associated with a reduction in mortality and severity of injuries.

Figure 2. Soldiers injured in Class A rollovers

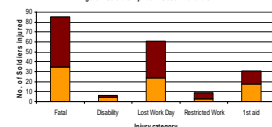
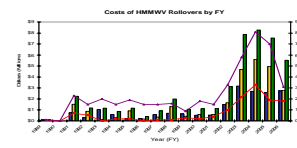
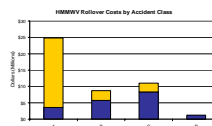


Figure 3. Soldiers injured in Class B-D rollovers



Figures 2 – 3 illustrate the number of Soldiers killed or injured by Accident Class. Figures 2 and 3 separates the Class A accidents from Class B – D accidents. Together these figures reinforce the proportional disparity of restraint use between those involved in catastrophic and less severe accidents.



Figures 4 – 5 highlight the economic impact by Accident Class and Fiscal Year (FY). The predominant cost is due to Injury Costs with the vast majority of costs occurring in Class A accidents. A similar trend emerges in Graph 5, where increased fatalities are associated with significantly higher financial costs.

Table 5. Cost of fatalities and cost reductions with increased restraint use.

	Cost of Fatalities	Cost per fatality	Personnel cost reduction by wearing restraints	Percent cost reduction per fatality
Upper limit	\$21,349,344	\$251,169	\$8,690,439	19.0%
Lower limit	\$6,483,788	\$76,280	\$2,639,283	5.8%

Risk Results

Table 6. Incidence values used for determining odds ratio and risk calculations.

	Fatal	Non-Fatal	Sum Total
Restraint Use = N	50	157	207
Restraint Use = Y	35	435	470
Sum Total	85	592	677

Table 7. Calculations associated with not using restraints.

Measure	Calculated value	Interpretation
Incidence Exposed	14.2	Rate of HMMWV rollover fatality without restraint use / yr / 1000 events
Incidence Unexposed	4.4	Rate of HMMWV rollover fatality with restraint use / yr / 1000 events
Incidence Population	7.4	Rate of HMMWV rollover fatality (with & without restraints) in population / yr / 1000 events
Odds Ratio	4.0	Odds of fatality if restraint system is not used
Attributable Risk (AR)	9.8	Rate of fatalities attributed to not wearing the restraint system
AR %	69.2%	Within this study, percent of avoidable fatalities if restraints had been used
Population AR (PAR)	3.0	Anticipated reduction of fatality incidents if restraints are used
PAR %	40.7%	Anticipated percent reduction of fatalities (due to HMMWV rollovers) if restraints are used by entire population

Conclusions/ Recommendations

These findings illustrate the costs of not "Buckling up"

1. Soldiers who do not wear restraints are involved in more severe accidents;
2. The economic costs of rollovers are predominantly due to injuries, specifically fatalities;
3. The odds of dying in a HMMWV rollover are four times greater if a restraint is not worn;
4. 69.2% of the deaths identified in this study could have been prevented by wearing restraints;
5. This translates to the general driver/passenger of a HMMWV as a 40.7% reduction of potential fatality in a rollover accident.

Limitations:

1. This analysis assumed cause of death due to blunt impact and/or flail injury and represents an upper limit of preventable injuries and economic costs.
2. Unable to control for other sources of morbidity and mortality in HMMWV rollover dataset due to insufficient details within the dataset.

Recommendations: Improved education regarding benefits and consequences of restraint use and increased enforcement of restraint use to reduce fatalities in the event of a HMMWV rollover.

